other. For scans in the direction of decreasing frequency, the five ratios so determined averaged to 1.2706211 with an average deviation of ± 0.0000018, whereas for scans in the other direction the ratios averaged to 1.2706272 ± 0.0000009. The two differ because of the lag introduced by the not negligible integrating time constant in the recording system ($RC = 10$ sec in two cascaded stages) compared to the time of passage through the line (4 min for the high-frequency line and 9 min for the low). Assuming this effect to be eliminated in the arithmetic average, the final result is

$$\mu(\mathrm{Ga}^{71})/\mu(\mathrm{Ga}^{69}) = 1.2706242 \pm 0.0000020,$$

where the estimated error is larger than the largest average deviation from the mean in the runs for one direction and makes some allowance for residual systematic error. This result is in excellent agreement with Schwartz's prediction from the hfs data.[1]

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Second Maximum in the Negative Pion Scattering Cross Section

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THE total cross section for scattering of negative pions by protons[1] has a pronounced second maximum at about 900 Mev. The cross section is about 30 mb at 700 Mev and at 1100 Mev, and rises between these limits to a peak value of about 50 mb. As Yang[2] and others have observed, it is difficult to interpret this maximum as a resonance in a single state of the meson-proton system. First, there is no maximum in the positive pion scattering at this energy, and so the excess scattering must occur in states of total isotopic spin $T=\frac{1}{2}$. Second, the maximum contribution to the total cross section from a state with $T=\frac{1}{2}$ and total angular momentum J is limited by

$$\sigma \leq (4\pi/3)\lambda\!\!\!^{-2}(2J+1)\rho, \tag{1}$$

where $\lambda\!\!\!^{-}$ is the de Broglie wavelength in the center-of-mass system, and ρ is the ratio of elastic to total cross section in the resonant state. Experimentally it appears[3] that $\rho \sim \frac{1}{3}$, so that taking $\sigma = 20$ mb and $\lambda\!\!\!^{-} = 3.45 \times 10^{-14}$ cm at 900 Mev, Eq. (1) would imply

$$J \geq 11/2, \tag{2}$$

which is highly unlikely at this energy. For this and other reasons, it is believed that several angular momentum states with $T=\frac{1}{2}$ must simultaneously give maximum cross sections at 900 Mev, while none of the states with $T=\frac{3}{2}$ does so.

The following simple hypothesis[4] appears to give a qualitative explanation of the facts. Suppose there is a strongly interacting or resonant state of two mesons which collide at a relative momentum of 250 Mev/c. We consider the excess inelastic $\pi^- - p$ scattering to be a resonant elastic scattering of the incident meson by a meson in the charge cloud around the proton. The second meson is supposed to be "loosely bound" so that the interaction usually results in both mesons escaping from the proton. If the resonant state has $T=0$ it will contribute nothing to $\pi^+ - p$ scattering at this energy. The excess scattering will be observed in several angular momentum states of the $(\pi^- - p)$ system simultaneously.

The maximum excess cross section is given by

$$\sigma = (4\pi/3)\lambda\!\!\!^{-2}(2I+1)F, \tag{3}$$

where I is the angular momentum of the resonant state, $\lambda\!\!\!^{-} = 7.87 \times 10^{-14}$ cm is now the de Broglie wavelength in the center-of-mass system of the two mesons, and F is the probability of finding a positive pion in the proton charge cloud. With $\sigma = 20$ mb, (3) gives

$$(2I+1)F \geq 0.77, \tag{4}$$

which is possible if $I=0$ and is easily to satisfy if $I=2$. [$T=0$ states must have even parity.]

The main predictions on which this hypothesis may be tested are these:

(i) The excess inelastic scattering should lead entirely to outgoing neutrons and not to protons.

(ii) The final states should be $(n+\pi^+ + \pi^-)$ and $(n+2\pi^0)$ in the ratio 2:1.

(iii) The neutron should be emitted with very low energy in the lab system, 20 Mev being an estimated average value.

The width of the observed maximum is compounded from the natural width of the 2-meson resonance and the momentum distribution of the meson in the charge cloud. On this basis the resonance may be estimated to have a width at half-maximum of 50–100 Mev/c in momentum units. It is not clear, however, whether such an estimate based on an "impulse approximation" has any validity.

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[4] This idea was suggested by O. Piccioni several years ago, before any experiments existed to support it.